

THE CARBON SEQUESTRATION NEWSLETTER

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March 2006

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Sequestration in the News

DOE Techline, "DOE Launches Carbon Dioxide Sequestration Initiative," The US Department of Energy (DOE) has launched a new research effort aimed at enhancing recovery of oil and natural gas while sequestering carbon dioxide (CO₂). A solicitation has been issued to provide oil and gas producers grants to conduct field testing and validation of enhanced recovery/sequestration technologies. (See this newsletter's Announcement inset box for **Funding Opportunity Announcement for 'Enhanced Oil and Natural Gas Production through Carbon Dioxide Injection,'** and link to the RFP at: <http://www.grants.gov/search/search.do?mode=VIEW&oppId=7838>.)

The projects will be managed by the National Energy Technology Laboratory (NETL). Currently, the use of enhanced oil recovery (EOR) accounts for 4 percent of US oil production. Enhanced gas recovery (EGR), flooding natural gas reservoirs with carbon dioxide (CO₂) to move previously bypassed natural gas to producing wells, is not widely used. Oil and gas fields' capacity for CO₂ sequestration was shown to equate to 125 years of current worldwide emissions from fossil-fuel-fired power plants in a study conducted for DOE. The growth potential of CO₂ flooding was detailed in a series of

reports on six regions of the US released in April 2005 by the Office of Fossil Energy. The reports concluded that CO₂ flooding in large, favorable reservoirs could yield more than 43 barrels of incremental oil, increasing US oil production by 2-3 million barrels per day by 2025. See reports at: http://www.fossil.energy.gov/programs/oilgas/eor/Six_Basin-Oriented_CO2-EOR_Assessments.html. A DOE sponsored workshop on Enhanced Oil Recovery was hosted by the Petroleum Technology Transfer Council in Houston, Texas on February 22, February 13, 2006, http://www.netl.doe.gov/publications/press/2006/06008-EOR_Sequestration_Initiative.html.

FutureGen Site Selection Begins



BP Press Release, "BP and Edison Mission Group Plan Major Hydrogen Power Project for California," BP and Edison Mission Group, a subsidiary of Edison International, are planning a \$1 billion hydrogen-fueled power plant and petroleum coke gasification project adjacent to a BP refinery in Carson, California. The 500 megawatt plant will combine a number of technologies to reduce carbon dioxide (CO₂) emissions. Petroleum coke will be converted to hydrogen and CO₂ gases, with 90 percent of the CO₂ captured and separated. The hydrogen

HIGHLIGHTS

DOE Techline, and FutureGen Alliance Website, "FutureGen Industrial Alliance Announces Site Selection Process for World's First "Zero Emissions" Coal Plant," The FutureGen Alliance (the Alliance) will build the FutureGen plant on a site selected through an open, competitive site-selection process. According to the FutureGen Alliance website, they accepted comments and clarifying questions on the draft Request for Proposals (RFP) through midnight (Eastern Standard Time) on February 28, 2006, with a final RFP targeted for release on March 7, 2006. View the draft RFP at: http://www.futuregenalliance.org/news/draft_siting_rfp.pdf. The proposals for the host site are due in May 2006. The Alliance will develop a list of candidate sites by the summer of 2006 based on an evaluation of the proposals received. Information about the process is provided on the FutureGen Alliance website: <http://www.futuregenalliance.org/>. Prospective site offerors, architecture and engineering firms, technology suppliers and other service providers are encouraged to monitor the Alliance website for participation opportunities. Draft RFPs, Request for Qualifications, and questions and answers to appear at: <http://www.futuregenalliance.org/news.stm>. Members of the Alliance include: American Electric Power; BHP Billiton; the China Huaneng Group; CONSOL Energy Inc.; Foundation Coal; Kennecott Energy, a member of the Rio Tinto Group; Peabody Energy; and Southern Company. February 8, 2006, http://www.netl.doe.gov/publications/press/2006/06007-FutureGen_Site_Selection_Process.html.

gas stream will fuel the gas turbine to generate electricity. The captured CO₂ will be liquefied and piped to oil fields for enhanced oil recovery. BP is discussing options for sequestering the CO₂ in Occidental Petroleum's California oilfields. Occidental currently operates the Elk Hills field in California's southern San Joaquin Valley, the THUMS operation in Long Beach and other properties in the Sacramento Valley in northern California. A final decision on the plant is expected in 2008 with operations to begin in 2011. For more information on the Carson project visit: <http://www.bp.com/hydrogenpower>. February 10, 2006, http://www.bpalternativenergy.com/liveassets/bp_internet/alternativenergy/press_10_02_06.html. Also see article in *The New York Times*, "**Power Plant Would Reuse Carbon Dioxide**," <http://www.nytimes.com/2006/02/11/business/11power.html>. (Subscription may be required), *Natural Gas Week's "Hydrogen Growth Spurring Gasification Projects*," <http://www.energyintel.com> (Subscription may be required), and *Occidental Oil's Press Release "Occidental and BP to Evaluate CO₂ Sequestration Options for California*," <http://www.primezone.com/newsroom/news.html?d=93867>.

Press Release (Western Governors' Association), "WGA Advisory Committee to Consider Array of Options for Increasing Clean Energy, Efficiency in the West," The Western Governors' Association's Clean and Diversified Energy Advisory Committee (CDEAC) is set to consider an array of options for bringing on-line 30,000 megawatts of clean energy by 2015, increasing energy efficiency 20 percent by 2020 and providing adequate transmission for their region. The Western Governors' Association (WGA) is an independent, nonprofit organization representing the governors of 18 states and three US-Flag islands in the Pacific. The WGA identifies and addresses key policy and governmental issues in natural resources, the environment, human services, economic development, international relations and public management. A policy resolution outlining their visions and goals was launched in 2004 called the Clean and Diversified Energy Initiative. On January 10, the CDEAC released several task force reports that examine the feasibility of and options for reaching their goals, including reports in the area of advanced coal. The reports will be utilized by the CDEAC in developing recommendations for the WGA to consider at their 2006 annual meeting, June 11-13 in Sedona, Arizona. See: <http://www.westgov.org/wga/initiatives/cdeac/index.htm> for links to the reports and also the Reports section of this newsletter "**Carbon Management Working Group Report for the Advanced Coal Task Force, Western Governors' Association**," for more information. January 10, 2006, <http://www.westgov.org/wga/press/cdeac1-10-06.htm>.

Reuters, "US Power Providers Say They Expect Carbon Regime," At the Cambridge Energy Research Associates' CERA Week 2006 Energy Conference held in Houston, Texas, February 6-10, US power company executives said they expect a series of rules and taxes will be imposed on carbon pollution, possibly within five years. James Rogers, chairman and chief executive of Cinergy Corp, felt there is a 25 percent chance that carbon will be regulated by 2009. The executives said carbon sequestration will likely be a focus of future legislation with taxes and a pollution credit trading system. Walter Higgins, chairman, president and chief executive of Sierra Pacific Resources, said, "All of forms of power gen-

eration create carbon. Some sort of carbon sequestration is the most likely intermediate-term carbon solution." February 10, 2006, <http://www.planetark.com/dailynewsstory.cfm?newsid=35019&newsdate=10-Feb-2006>.

Oil and Gas Journal, "Shell CEO Says Technology Needed to Meet Fuel Demand," At the CERA Week 2006 Energy Conference in Houston, Jeroen van der Veer, chief executive of Royal Dutch Shell PLC, stated that the oil and gas industry needs to apply new technologies on an unprecedented scale and pace to meet the world's demand for fossil fuels. Assuming continued economic growth, the world's energy needs may increase by 100 million barrels per day of crude over the next 25 years—"more than we added over the past quarter century," said Van der Veer. He stated that most of the increased demand will be in new markets where infrastructure and international trade must be developed. "And this has to go together with cutting carbon dioxide emissions from energy," he said. "I have a vision of green—or greener—fossil fuels with much of their carbon dioxide captured and sequestered either underground or in inert materials," Van der Veer said. He stated that he feels sequestration for power plants should be a priority. February 10, 2006, http://ogj.pennnet.com/articles/article_display.cfm?Section=ONART&C=GenIn&ARTICLE_ID=247775&p=7.

BBC News, "Rocks Could Store All Europe's CO₂," On BBC World's Service's One Planet program, Statoil's Senior Vice President for the Environment, Tor Fraeren, stated that one million tons of carbon dioxide (CO₂) are stored every year in the formations under the Sleipner platforms in the North Sea. He also said that there are calculations which say these same formations could handle all of Europe's CO₂ emissions for several hundred years, illustrating the site's potential capacity for CO₂ storage. He then pointed out how in actuality countries other than Norway would incur large costs to pipe CO₂ to the site. The Norwegian Energy Minister, Odd Roger Enoksen, explained Norway's plan to link the Sleipner platforms to a gas power plant on Norway's west coast, with CO₂ capture starting in 2009. The One Planet Program toured the Sleipner platform to look at its CO₂ capture and storage systems and discuss carbon sequestration. February 16, 2006, <http://news.bbc.co.uk/2/hi/business/4717578.stm>.

Chemistry World (UK), "Calls for UK Investment in Carbon Capture," The Science and Technology Committee of the House of Commons of the Parliament of the United Kingdom (UK) has released a report "**Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage**." In the report, the parliamentary committee urged the UK government to invest in carbon capture and sequestration. The committee called on the government to invest in UK-based technology for storing carbon dioxide (CO₂) in geologic formations. They also urged that new UK industrial plants should be obliged to incorporate carbon capture and storage (CCS) technology. The report also said that the government's energy review, currently in progress, must ensure full

scale CCS demonstration projects are in place by 2009. Annette Cutler, founder of the European Knowledge Transfer Network CO₂NET, commented on the contents of the report saying, "For climate needs, emissions reductions by other heavy industry, such as fertilizer and chemical plants, aluminum smelters and iron and steel works are of significance and could utilize CCS technology as effectively as the power industry." To access the report online in the pdf or html version see: <http://www.publications.parliament.uk/pa/cm/cmsctech.htm>, far left under the heading: "Report, February 9, 2006, First Report, Meeting UK Energy and Climate Needs." February 9, 2006, <http://www.rsc.org/chemistryworld/News/2006/February/09020601.asp>.

The Times-Reporter (OH), "State Commits Money for Plant Project," Ohio has committed to securing \$2 million in funding for test drilling for potential sites for the FutureGen facility. The test drilling will document geologic characteristics of proposed sites to help determine the best location for the plant. Tuscarawas County is proposing a 790-acre site between Port Washington and Gnadenhutten. Coshocton and Stark counties are actively supporting the Tuscarawas County site, while Carroll County is pushing two sites of its own, according to a community development representative. February 17, 2006, <http://www.timesreporter.com/left.php?ID=50801&r=3>.

Waco Tribune-Herald (TX), "Mexia Won't Host Experimental Power Plant, But a Nearby Site Might," Although the city of Mexia in Central Texas will not be considered for a FutureGen proposed site, another location—near the city of Jewett, located at the junction of the counties of Limestone, Freestone and Leon—will be considered by the state. Nine Texas groups have submitted proposals to the state, and a state task force will pick an appropriate site to propose for the plant in the next few months. The Mexia site was not chosen due to a number of uncapped wells in the old Mexia oil field. February 12, 2006, <http://www.wacotrib.com/news/content/news/stories/2006/02/12/20060212wacmexiaplant.html>

Science

Palladium Item (Richmond, IN), "No-Till Historic Experiment Reaches Middle Age," After 45 years, the no-till soil plots set up in 1962 by scientists Glover Triplett and Dave VanDoren may not have enough funding to be maintained. The Triplet-Van Doren plots were critical in supporting some of the earliest work on no-till carbon sequestration. On average, the Ohio soils can sequester about 500 pounds of carbon per acre. Supporters have mounted a campaign to fund the research and upkeep of the plots. February 12, 2006, <http://www.pal-item.com/apps/pbcs.dll/article?AID=/20060212/NEWS01/602120322/1008>.

Announcements

FutureGen Alliance Accepting Comments on Draft RFP for Facility Host Site. According to the FutureGen Alliance website, they will accept comments and clarifying questions on the draft Request for Proposals (RFP) through February 28, 2006, with a final RFP targeted for release on March 7, 2006. View the draft RFP at: http://www.futuregenalliance.org/news/draft_siting_rfp.pdf.

US Department of Energy Solicits Comments on FutureGen Advance Notice of Intent (ANOI). Comments from the public and others are being accepted on the ANOI to prepare an Environmental Impact Statement, as part of the National Energy Policy Act (NEPA) of 1969, for implementation of the FutureGen Project. Comments related to the NEPA process are due by March 20, 2006 and should be submitted to Mark L. McKoy, NEPA Document Manager for the FutureGen Project. See Volume 71, *Federal Register*, pages 8283-8287, February 16, 2006, or this link: <http://www.eh.doe.gov/nepa/noi/8283.pdf>

Funding Opportunity Announcement for "Enhanced Oil and Natural Gas Production Through Carbon Dioxide Injection." On February 1, 2006 the US Department of Energy's (DOE) National Energy Technology Laboratory announced funding opportunity DE-PS26-06NT15430 to fund projects for testing and validating technologies that integrate enhanced recovery and carbon dioxide (CO₂) sequestration. The projects require a 50 percent cost-share by the recipient. The total estimated federal funding will be \$7 million to \$8 million, with DOE expecting to fund two to four projects. Applications are due May 5, 2006. See <http://www.grants.gov/search/search.do?mode=VIEW&oppld=7838> for details.

"Public Comments Being Accepted on Draft Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2004," The February 27, 2006 *Federal Register* announced that public comments are being accepted by or before March 29, 2006 on the Draft Inventory of US Greenhouse Gas Emissions and Sinks inventory. Comments can be sent to Leif Hockstad at hockstad.leif@epa.gov or Lisa Hanle at hanle.lisa@epa.gov. See: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2006.html>.

UNFCCC Newsletter. On February 16, 2006, the United Nations Framework Convention on Climate Change (UNFCCC) launched the inaugural edition of the UNFCCC newsletter. Distributed bimonthly, the UNFCCC Newsletter will provide a comprehensive overview of major news and announcements, along with practical information about upcoming events. To subscribe, visit: http://unfccc.int/essential_background/newsletter/items/3642.php.

UNFCCC interactive map and reporting system for the CDM. To coincide with the one-year anniversary of the Kyoto Protocol coming into force (February 16, 2005), the United Nations Framework Convention on Climate Change has launched an interactive map and reports on its website showing Clean Development Mechanism project locations and status. See map at: <http://cdm.unfccc.int/Projects/MapApp> and reports at: <http://cdm.unfccc.int/Statistics>.



Reuters, "Greenland Glaciers Melting Faster, Study Finds," The authors of the article "Changes in the Velocity Structure of the

Greenland Ice Sheet," from the February 17, 2006 **Science** magazine, find that the ice loss due to glacier flow in Greenland has increased from 12 cubic miles of ice loss per year in 1996 to 36 cubic miles of ice per year in 2005. Rising temperatures are a factor, with the temperature in southeast Greenland rising by 5.4 degrees Fahrenheit over the last 20 years. The authors calculated that Greenland contributes 0.02 inch to the annual 0.1 inch rise in global sea levels. One author stated that the southern half of Greenland is reacting to climate warming with the northern half waiting, though it may not take long for the northern part to react. February 17, 2006, http://today.reuters.com/news/newsArticle.aspx?type=scienceNews&storyID=2006-02-16T193330Z_01_N16367561_RTRUKOC_0_US-ENVIRONMENT-GLACIERS.xml&archived=False

Defra Press Release, "How much climate change can we take?" A new book "Avoiding Dangerous Climate Change" was released with the forward written by Britain's Prime Minister Tony Blair. The government-commissioned book collates evidence for global warming presented at the conference of the same name, which took place at Britain's meteorological office (the Met) in February 2005 at the start of the UK's G8 Presidency. The book and an executive summary are available on the Department for Environment, Food and Rural Affairs (Defra) website at: <http://www.defra.gov.uk/environment/climatechange/internat/dangerous-cc.htm>. January 30, 2006, <http://www.defra.gov.uk/news/2006/060130c.htm>.

Policy

Greenwire, "Kyoto Goal Can Be Met, But Tougher Rules are Needed, UN Says," The United Nations Framework Convention on Climate Change (UNFCCC) said that the report filed by industrialized nations to the organization in the beginning of 2006 showed "significant progress," but that stricter greenhouse gas emissions-curbing efforts are needed. Richard Kinley, acting head of the UNFCCC, said that as a whole the countries were progressing toward lowering emissions levels by at least 3.5 percent below 1990 levels by the 2008-2012 target. With tougher reduction measures, the countries may reach target of at least 5 percent cut below 1990 levels. Download UNCCC Press Release at: http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20060215_anniversary_kp_entry_into_force.pdf. February 15, 2006, <http://www.eenews.net/Greenwire/2006/02/15/#9>. (Subscription maybe required.)

BBC News, "Britain's Emissions Plan Rejected," The European Commission rejected Britain's revised carbon dioxide (CO₂) emissions plans on procedural grounds. Britain made changes to its original plan, increasing it by nearly 3 percent (about 20 million metric tons) of CO₂ for 2005-2007, which was then disputed by the Commission. The European Union (EU) Court of First Instance sided with Britain in the dispute, ruling in November that the country could make changes, even those which would mean easing pollution limits for industry. Now the commission has rejected Britain's amended plan on the grounds of late submission, saying that Britain missed the September 30, 2004 deadline. February 22, 2006, http://news.bbc.co.uk/2/hi/uk_news/4740878.stm.

Reuters, "EU's Dimas Says to Approve Italy CO₂ Plan Shortly," Italy's allocation plan for carbon dioxide (CO₂) emissions will receive final approval from the European Union's executive arm in a few days, said EU's Environment Commissioner Stavros Dimas. February 16, 2006, <http://www.planetark.com/dailynewsstory.cfm?newsid=35140&newsdate=16-Feb-2006>

BBC News, Carbon Map Shows Worst Offenders. The Carbon Trust published a map detailing the amount of carbon emitted per square kilometer per year, and emissions per person for 33 urban areas in the UK. London leads the list with 9.46 million metric tons of carbon emitted annually (1.09 metric tons per person). To view the map see: <http://www.carbonmap.co.uk/>. February 21, 2006, http://news.bbc.co.uk/2/hi/uk_news/4735872.stm

Geology

"Seismic Imaging for Site Selection and Monitoring of Carbon Dioxide Sequestration Part 1—Field Studies." This is the first in a two part series from the *GasTips*, a publication of Gas Technology Institute, the US Department of Energy and Hart Energy Publishing which covers technology developments in natural gas exploration, production and processing. The Gas Technology Institute, with support from Illinois Clean Coal Institute and cooperation of the Illinois State Geological Survey, designed and implemented a comprehensive research project aimed at determining the viability of seismic techniques for site selection and monitoring of carbon dioxide sequestration in Illinois coals. Read details of the studies starting on page 3 of the pdf file of the Fall 2005 *GasTips*, which is available at: <http://www.netl.doe.gov/technologies/oil-gas/publications/GasTIPS/GasTIPS-Fall2005.pdf>

"The influence of temperature on adsorption capacity of Malaysian coal," The paper highlights the study of carbon dioxide (CO₂) adsorption profiles of local coal samples of varying mean size distributions (1000 and 2000 micrometers (µm)) obtained from Miri, Sarawak situated in the East of Malaysia, at different temperatures (24.6, 30, 40 and 55 degrees Celsius). Parameters such as the moisture content, ash content, carbon content and mineral content of the coal sample were investigated. Based on the physical analysis of the coal, it was classified as lignite, which exhibits a better adsorptive affinity for

CO₂. In addition, the coal sample having the smaller mean particle size distribution of 1000 μm shows a better rate of adsorption compared to the 2000 μm size distribution. The adsorption capacity of the coal sample shows an inverse relationship with temperature. These findings open a platform for CO₂ sequestration to be implemented in Malaysia. *Chemical Engineering and Processing*, Volume 45, Issue 5, May 2006, Pages 392-396. <http://www.sciencedirect.com/science/article/B6TFH-4HNSJC1-1/2/f8508e07ca6ddd8f3b502605bcffc684> (Subscription may be required.)

Technology

“Using steam reforming to produce hydrogen with carbon dioxide capture by chemical-looping combustion,” In this paper, a novel process for hydrogen production by steam reforming of natural gas with inherent capture of carbon dioxide by chemical-looping combustion is proposed. The process resembles a conventional circulating fluidized bed combustor with reforming taking place in reactor tubes located inside a bubbling fluidized bed. Energy for the endothermic reforming reactions is provided by indirect combustion that takes place in two separate reactors: one for air and one for fuel. Oxygen is transferred between the reactors by a metal oxide. There is no mixing of fuel and air so carbon dioxide for sequestration is easily obtained. Process layout and expected performance are evaluated and a preliminary reactor design is proposed. It is found that the process should be feasible. It is also found that it has potential to achieve better selectivity towards hydrogen than conventional steam reforming plants due to low reactor temperatures and favorable heat-transfer conditions. *International Journal of Hydrogen Energy*, available online January 26, 2006, <http://www.sciencedirect.com/science/article/B6V3F-4J4B93Y-1/2/6be7f6e05f3ba37380b2e01b81135079>. (Subscription may be required.)

“A comparison of electricity and hydrogen production systems with CO₂ capture and storage—Part A: Review and selection of promising conversion and capture technologies,” The authors performed a consistent comparison of state-of-the-art and advanced electricity and hydrogen production technologies with carbon dioxide (CO₂) capture using coal and natural gas, inspired by the large number of studies, of which the results can in fact not be compared due to specific assumptions made. After literature review, a standardization and selection exercise was performed to get figures on conversion efficiency, energy production costs and CO₂ avoidance costs of different technologies, the main parameters for comparison. On the short term, electricity can be produced with 85–90 percent CO₂ capture by means of natural gas combined cycle (NGCC) and pulverized coal-fired (PC) with chemical absorption and integrated gasification combined cycle (IGCC) with physical absorption at 4.7–6.9 European union cents per kilowatt hour (€/kWh) (which is equivalent to a range of 5.3–7.8 US cents, at the 2003 average exchange rate assumed in the paper of 0.885 €/US\$), assuming a coal and natural gas price of 1.7 and 4.7 Euros per gigajoule (€/GJ) (equivalent to 1.9 and 5.3 \$/GJ). CO₂ avoidance costs are between 15 and 50 Euros per ton of CO₂ (€/t CO₂), (or approximately 17 and 57 \$/t CO₂) for IGCC and

NGCC, respectively. On the longer term, both improvements in existing conversion and capture technologies are foreseen as well as new power cycles integrating advanced turbines, fuel cells and novel (high-temperature) separation technologies. Electricity production costs might be reduced to 4.5–5.3 (€/kWh), (or approximately 5.1–6.0 US cents/kWh) with advanced technologies. However, no clear ranking can be made due to large uncertainties pertaining to investment and O&M costs. Hydrogen production is more attractive for low-cost CO₂ capture than electricity production. Costs of large-scale hydrogen production by means of steam methane reforming and coal gasification with CO₂ capture from the shifted syngas are estimated at 9.5 and 7 €/GJ (or 10.7 and 8 \$/GJ), respectively. Advanced autothermal reforming and coal gasification deploying ion transport membranes might further reduce production costs to 8.1 and 6.4 €/GJ (9.2 and 7.2 \$/GJ). Membrane reformers enable small-scale hydrogen production at nearly 17 €/GJ (19 \$/GJ) with relatively low-cost CO₂ capture. *Progress in Energy and Combustion Science*, available online January 20, 2006, doi:10.1016/j.pecs.2005.11.005, <http://www.sciencedirect.com/science/article/B6V3W-4J32JB0-1/2/882ac9be2cee316554fddcab68b009f4>. (Subscription may be required.)

“Polymeric CO₂/N₂ gas separation membranes for the capture of carbon dioxide from power plant flue gases,” One mitigation option for the reduction of greenhouse gas emissions involves the capture of carbon dioxide from flue gases followed by underground sequestration. For this technology to become widespread, new methods of capturing carbon dioxide must be devised. While capture of carbon dioxide with amine solvents is the most mature technology, another possible contender is gas separation membranes. This review paper focuses on novel materials for gas separation. In particular, polymeric gas separation membranes are examined. Possible design strategies, synthesis, fabrication and role of novel materials are discussed. *Journal of Membrane Science*, available online February 17, 2006, doi:10.1016/j.memsci.2005.12.062, <http://www.sciencedirect.com/science/article/B6Tgk-4J90W1G-1/2/294ee603a3982c9caf1fc40edbe752b0>. (Subscription may be required.)

“A 300 W laboratory reactor system for chemical-looping combustion with particle circulation,” Chemical-looping combustion (CLC) is a method to burn gaseous fuels with inherent separation of carbon dioxide. A continuously operated laboratory reactor system for chemical-looping combustion with two interconnected fluidized beds was designed and built. This chemical-looping combustor was designed to operate with a fuel flow corresponding to 100–300 watts (W). The CLC system was operated successfully using a highly reactive nickel-based oxygen-carrier. Furthermore, tests were carried out to determine the degree of gas leakage between the reactors. Although there was some leakage between the fuel and air reactors, it is low enough to enable evaluation of the combustion results. The combustion tests showed a high conversion of the natural gas to carbon dioxide, indicating that the particles are suitable for chemical-looping com-

bustion. No methane was detected in the gas from the fuel reactor, and the fraction of carbon monoxide was in the range 0.5–3 percent. *Fuel*, available online February 17, 2006. doi:10.1016/j.ijhydene.2005.12.003, <http://www.sciencedirect.com/science/article/B6V3F-4J4B93Y-1/2/6be7f6e05f3ba37380b2e01b81135079>. (Subscription may be required.)

“Techno-economic prospects of small-scale membrane reactors in a future hydrogen-fuelled transportation sector,” A membrane reactor is a novel technology for the production of hydrogen from natural gas. It promises economic small-scale hydrogen production, e.g. at refueling stations, and has the potential of inexpensive carbon dioxide separation. Four configurations of a membrane reactor have been modeled with Aspen^{plus} to determine its thermodynamic and economic prospects. Overall energy efficiency is 84%_{HHV} (higher heating value) without H₂ compression (78 percent with compression up to 482 bar). The modeling results also indicate that by using a sweep gas, the membrane reactor

can produce a reformer exit stream consisting mainly of carbon dioxide (CO₂) and H₂O (>90%_{mol}) suited for CO₂ sequestration after water removal with an efficiency loss of only 1%_{pt} (pt = percentage points). Reforming with a 2 megawatt (MW) membrane reactor (250 unit production volume) costs 14 dollars per gigajoule of H₂ (\$/GJ_{H2}) including compression, which is more expensive than conventional steam reforming and compression (12 \$/GJ). It does, however, promise a

cheap method of CO₂ separation, 14 dollars per ton (\$/t) CO₂ captured, due to the high purity of the exit stream. The well-to-wheel chain of the membrane reactor has been compared to centralized steam reforming to assess the trade-off between production scale and the construction of a hydrogen and a CO₂ distribution infrastructure. If the scale of centralized hydrogen production is below 40 MW, the trade-off could be favorable for the membrane reactor with small-scale CO₂ capture -18 \$/GJ including H₂ storage, dispensing and CO₂ sequestration for 40 MW steam methane reforming (SMR) versus 19 \$/GJ for the membrane reactor. The membrane reactor might become competitive with conventional steam reforming provided that thin membranes can be combined with high stability and a cheap manufacturing method for the membrane tubes. Thin membranes, industrial utility prices and larger production volumes (i.e. technological learning) might reduce the levelized hydrogen cost of the membrane reactor at the refueling station to less than 14 \$/GJ including CO₂ sequestration cost, below that of large-scale H₂ production with CO₂ sequestration (~15 \$/GJ). *Energy*, available online February 2, 2006, doi:10.1016/j.energy.2005.12.004, <http://www.sciencedirect.com/science/article/B6V2S-4J5T5RM-2/2/18f7d8576e051f4aabf48010d40593f7>. (Subscription may be required.)



“The development of nanoporous membranes for separation of carbon dioxide at high temperatures,” The development of nanoporous membranes for separation of carbon dioxide at high temperatures Initial observations from permeation experiments are reported for a class of novel membranes which display potential in the area of high temperature (~900 K) gas separations. The existence of these membranes was first postulated from theoretical studies on transport of gases through ultra-thin (~5–25 nm), nanoporous silica. The experimental results presented here confirm these observations, as demonstrated by membranes produced with kinetic selectivities for carbon dioxide/nitrogen greater than 75:1 at 873 K. *Journal of Membrane Science*, available online, January 24, 2006, doi:10.1016/j.memsci.2005.12.021, <http://www.sciencedirect.com/science/article/B6TGK-4J3WS9C-3/2/bcaaaae21f726e7cc797a3c0bbbd4577>. (Subscription may be required.)

Terrestrial/ Ocean

“An Overview of Terrestrial Sequestration of Carbon Dioxide: the United States Department of Energy's Fossil Energy R&D Program.”

The US Department of Energy (DOE) is sponsoring the development of new technologies that can provide energy and promote economic prosperity while reducing greenhouse gas (GHG) emis-

sions. One option that can contribute to achieving this goal is the capture and sequestration of carbon dioxide in geologic formations. An alternative approach is carbon sequestration in terrestrial ecosystems through natural processes. Enhancing such natural pools (known as natural sequestration) can make a significant contribution to CO₂ management strategies with the potential to sequester about 290 teragrams of carbon per year (Tg C/y) in US soils. In addition to soils, there is also a large potential for carbon sequestration in above and belowground biomass in forest ecosystems. A major area of interest to DOE's Fossil Energy Program is reclaimed mined lands, of which there may be 0.63x10⁶ hectares in the US. These areas are essentially devoid of soil carbon; therefore, they provide an excellent opportunity to sequester carbon in both soils and vegetation. Measurement of carbon in these ecosystems requires the development of new technology and protocols that are accurate and economically viable. Field demonstrations are needed to accurately determine carbon sequestration potential and to demonstrate the ecological and aesthetic benefits in improved soil and water quality, increased biodiversity, and restored ecosystems. The DOE's research program in natural sequestration

highlights fundamental and applied studies, such as the development of measurement, monitoring, and verification technologies and protocols and field tests aimed at developing techniques for maximizing the productivity of hitherto infertile soils and degraded ecosystems. Authors are John T. Litynski, Scott M. Klara, Howard G. McIlvried, and Rameshwar D. Srivastava. *Climatic Change*, published online January 5, 2006, doi:10.1007/s10584-005-6960-6, <http://springerlink.metapress.com/rlg5uz45m0dwo5vfavqcvq45/app/home/contribution.asp?ref=parent&backto=issue.5.11;journal.1.215;linkingpublicationresults.1:100247.1>. (Subscription may be required.)

“Universal scaling of respiratory metabolism, size and nitrogen in plants,” The scaling of respiratory metabolism to body size in animals is considered to be a fundamental law of nature, and there is substantial evidence for an approximate three quarter-power relation. Studies suggest that plant respiratory metabolism also scales as the three quarter-power of mass, and that higher plant and animal scaling follow similar rules owing to the predominance of fractal-like transport networks and associated allometric scaling. In this article, using data obtained from about 500 laboratory and field-grown plants from 43 species and four experiments, the authors show that whole-plant respiration rate scales approximately isometrically (scaling exponent approximately 1) with total plant mass in individual experiments and has no common relation across all data. Moreover, consistent with theories about biochemically based physiological scaling, isometric scaling of whole-plant respiration rate to total nitrogen content is observed within and across all data sets, with a single relation common to all data. This isometric scaling is unaffected by growth conditions including variation in light, nitrogen availability, temperature and atmospheric carbon dioxide concentration, and is similar within or among species or functional groups. These findings suggest that plants and animals follow different metabolic scaling relations, driven by distinct mechanisms. January 26, 2006, *Nature*, 439, 457-461, doi:10.1038/nature04282, <http://www.nature.com/nature/journal/v439/n7075/full/nature04282.html>. (Subscription may be required.)

“Carbon sequestration potential by afforestation of marginal agricultural land in the Midwestern US,” Carbon sequestration has been well recognized as a viable option to slow the rise in atmospheric greenhouse gas concentration. The main goals of this study were to assess the carbon sequestration potential (CSP) by afforestation of marginal agricultural land (MagLand) and to identify hotspots for potential afforestation activities in the US Midwest region (Michigan, Indiana, Ohio, Kentucky, West Virginia, Pennsylvania and Maryland). The 1992 USGS National Land Cover Dataset and the State Soil Geographic (STATSGO) database were used to determine MagLand. Two forest types (coniferous and deciduous) and two management practices (short-rotation versus permanent forest) were combined to form four afforestation scenarios. Simulation models were employed to predict changes in four carbon pools: aboveground biomass, roots, forest floor, and soil organic carbon (SOC). A scenario-generating tool was developed to detect the hotspots. The authors estimated that there was a total of 6.5 million hectares (Mha) MagLand available in the US Midwest region, which accounts for approximately 24 percent of the regional

total agricultural land. The CSP capacity was predicted to be 508–540 teragrams of carbon (Tg C) over 20 years and 1018–1080 Tg C over 50 years. The results indicate that afforestation of MagLand could offset 6–8 percent of current carbon dioxide emissions by combustion of fossil fuel in the region. This analysis showed only slight differences in carbon sequestration between forest types or between short-rotation and permanent forest scenarios. Note that this calculation assumed that all suitable MagLand in the US Midwest region was converted to forest and that “best carbon management” was adopted. The actual CSP could be less if the economical and social factors are taken into account. The most preferred locations for implementing the afforestation strategy were found to be concentrated along a west-east axis across the southern parts of Indiana, Ohio, and Pennsylvania, as well as in an area covering southern Michigan and northern parts of Indiana and Ohio. Overall, we conclude that afforestation of MagLand in the Midwest US region offers great potential for carbon sequestration. Future studies are needed to evaluate its economic feasibility, social acceptability, and operation capability. *Forest Ecology and Management*, Volume 223, Issues 1-3, March 1, 2006, Pages 415-427, Available online January 25, 2006. doi:10.1016/j.foreco.2005.12.044, <http://www.sciencedirect.com/science/article/B6T6X-4J4404J-4/2/fe7fd2f79cd804a18cb6b9bf21618618> (Subscription may be required.)

“Carbon sequestration in semi-arid rangelands: Comparison of Pinus ponderosa plantations and grazing exclusion in NW Patagonia,” The large global extension of arid and semi-arid regions together with their widespread degradation give these areas a high potential to sequester carbon. The authors explored the possibilities of semi-arid ecosystems to sequester carbon by means of rangeland exclusion and afforestation with *Pinus ponderosa* in northwestern Patagonia (Argentina). The authors sampled all pools where organic carbon accumulates in a network of five trios of adjacent grazed, non-grazed and afforested stands (age: 12–25 years, density: 605–1052 trees per hectare). After 15 years since trees were planted, afforestation added approximately 50 percent more carbon to the initial ecosystem carbon pool, with annual sequestration rate ranging 0.5–3.3 megagrams of carbon per hectare per year (Mg C ha⁻¹ year⁻¹). Carbon gains in afforested stands were higher above than below-ground (150 percent vs. 32 percent). Root biomass differences (374 percent more in afforested vs. grazed stands, probability (p) = 0.0011) explained below-ground carbon contrasts whereas soil organic carbon showed no differences with afforestation. By contrast, grazing exclusions did not result in significant changes in the total carbon storage in comparison with the adjacent grazed stands (p=0.42) suggesting a slow ecosystem recovery in the time frame of this study (approximately 15 years of exclusion). Nevertheless, higher litter amount was found in the former (+53 percent, p=0.07). Neither, soil organic carbon nor root carbon showed significant differences between grazed and non-grazed conditions. Considering that more than 1.1 millions of hectares of the studied ecosystems are highly degraded and suitable for tree planting, afforest-

ing this area could result in a carbon sequestration rate of 1.7 teragrams of carbon per year (Tg C year⁻¹), almost 6 percent of the current fossil fuel emissions of Argentina; however environmental consequences which could emerge from this deep land use shift must be taken into account when afforestation program are being designed. *Journal of Arid Environments*, January 26, 2006. doi:10.1016/j.jaridenv.2005.12.008, <http://www.sciencedirect.com/science/article/B6WH9-4J4B9BJ-1/2/49f030bd625b10e468f691344865bdd6>. (Subscription may be required.)

Trading

Carbon Market Update, February 14, 2006	
CCX-CFI 2005 (\$/tCO ₂) \$2.00	EU ETS-EUA 2005 (\$/tCO ₂) \$ 31.38
(Converted from € to US\$)	

Reuters, “Third Kyoto Pollution Scheme Close to Launch,” Joint Implementation (JI)—which allows industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in another industrialized country as an alternative to emission reductions in their own countries—is expected to pave the way for hundreds of projects in Russia and Eastern Europe. JI Projects are most likely to take place in central and eastern European transitional economies and the Russian Federation since there is more scope for cutting emissions at lower cost than in other industrialized nations. The first meeting of Kyoto Protocol’s Joint Implementation Supervisory Committee (JISC 01) occurred on February 2-3 on Bonn, Germany. JISC reached a quick agreement on the draft regulations. The vice chair of the supervisory board set up to steer the JI mechanism hopes to have JI running by May, or at least by July since there are many projects waiting to file for registration. The vice chair also stated that the funding for the JI mechanism was not a problem thus far, and that some counties which have committed funds have already provided the funding. For the webcast, report and resulting documents of the First Meeting of the Joint Implementation Supervisory Committee see: http://ji.unfccc.int/Sup_Committee/Meetings/. February 9, 2006, http://today.reuters.com/news/newsArticle.aspx?type=scienceNews&storyID=2006-02-09T164418Z_01_L0988057_RTRUKOC_0_US-ENVIRONMENT-KYOTO.xml.

Reuters, “UK Seen Split on Key Climate Change Proposal,” and **BBC News “Smaller Firms Could Trade Carbon”** and **“Whitehall in Greenhouse Gases Row”** The British government is split on whether to adopt a proposal to curb carbon emissions from 14,000 British companies. A proposal was published in December by the government-funded initiative, The Carbon Trust, detailing a trading scheme for carbon dioxide permits for small and medium sized businesses. Heavy industry and the power sector are already under the European Union Emissions Trading Scheme. Britain has self-imposed domestic goals for cutting carbon emissions by 20 percent of 1990 levels by 2010. Existing policy is on track for 10 percent reduction, with this proposal closing the gap be-

tween the 10 and 20 percent by about one quarter. Britain states that it is on track to meet the treaty-imposed Kyoto Protocol carbon emission targets for 2008 to 2012. See proposal online at: http://www.thecarbontrust.co.uk/carbontrust/about/about5_3.html. February 9, 2006, http://today.reuters.com/news/newsArticle.aspx?type=scienceNews&storyID=2006-02-09T163142Z_01_L08302465_RTRUKOC_0_US-ENVIRONMENT-BRITAIN-CO2.xml and February 2, 2006, <http://news.bbc.co.uk/1/hi/sci/tech/4669868.stm>.

Recent Publications

“Carbon Management Working Group Report for the Advanced Coal Task Force, Western Governors’ Association,” In light of concerns about the potential impacts of anthropogenic greenhouse gas emissions on climate change, the Carbon Management Working Group was established to provide guidance to the Western Governors’ Association (WGA). Numerous carbon management opportunities are available to the states included in the WGA. This report discusses methods to store – or “sequester” – carbon captured from power plant emissions, options for advancing the management of captured carbon, and options to offset these emissions. Carbon sequestration has emerged as a key technology pathway to achieve substantial reductions in greenhouse gas emissions at relatively low cost while continuing use of fossil fuel energy supplies. The



analysis focuses on the physical, economic and policy requirements necessary to enable carbon sequestration as a carbon management option in the western states. The report looks at the 2005-2020 timeframe and recommends implementation of specific projects along a timeline that would significantly advance carbon sequestration in WGA states. Western states have enormous potential to sequester carbon dioxide; a variety of policy options can better position the West to achieve this potential in the future. Included in the list of contributors are three National Energy Technology Laboratory contributors including: Scott Klara, Sean Plasynski, and Rameshwar Srivastava. January 10, 2006. <http://www.westgov.org/wga/initiatives/cdeac/index.htm>. To view the complete report see: <http://www.westgov.org/wga/initiatives/cdeac/Coal-carbon.pdf>. For Policy recommendations of the Task Force see: <http://www.westgov.org/wga/initiatives/cdeac/Coal-policy.pdf>. For technology options presented by the task force see: <http://www.westgov.org/wga/initiatives/cdeac/Coal-technology.pdf>. To download reference documents see: <http://www.westgov.org/wga/initiatives/cdeac/Coal-technology-2015.xls>, <http://www.westgov.org/wga/initiatives/cdeac/Coal-technology-2025.xls>, and <http://www.westgov.org/wga/initiatives/cdeac/Coal-technology-cost.xls>.

“Annual Energy Outlook 2006 (AEO 2006), Full Report,”

The Energy Information Administration (EIA) released the *Annual Energy Outlook 2006 (AEO2006)* full report on its website on February 14, 2006. In preparing projections for the AEO2006, EIA evaluated a wide range of trends and issues that could have major implications for US energy markets between now and 2030. View the report at: <http://www.eia.doe.gov/oiaf/aeo/index.html>. The AEO Supplemental tables were generated for the reference case of the AEO2006 using the National Energy Modeling System, a computer-based model which produces annual projections of energy markets for 2003 to 2030. Link to the one hundred seventeen Supplemental Tables through: <http://www.eia.doe.gov/oiaf/aeo/supplement/index.html>.

“Agenda for Climate Action.” The Pew Center for Global Climate Change has issued a report that takes a comprehensive look at a suite of climate, energy, and technology policies that could provide reductions in greenhouse gases in the US. The report identifies both broad and specific policies, combining recommendations on economy-wide mandatory emissions cuts, technology development, scientific research, energy supply, and adaptation with critical steps that can be taken in key sectors. Fifteen specific recommendations are given in 6 areas: (1) science and technology, (2) market-based programs, (3) sectoral emissions, (4) energy production and use, (5) adaptation, and (6) international engagement. Geologic carbon sequestration, separation and capture technologies, emissions trading, agricultural sequestration, and other areas are specifically mentioned. February 2006. Download a brochure listing the recommendations at: <http://www.pewclimate.org/docUploads/Agenda%5FBrochure%5F2%2E08%2Epdf>. For the full report see: http://www.pewclimate.org/global-warming-in-depth/all_reports/agenda_for_climate_action/index.cfm.

“Draft Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2004 (February 2006),” The US Environmental Protection Agency (EPA) released the draft report of US greenhouse gas emissions, summarizing and presenting annual emissions by source category and sector. In 2004, greenhouse gas emissions in the US increased by 1.7 percent from the previous year. Total emissions were equivalent to 7,075 million metric tons for carbon dioxide. The largest source of emissions was fossil fuel combustion, accounting for 80 percent of the total. The report also includes estimates of carbon sequestration in U.S. forests. See announcements section of this newsletter for information on Public Comments Being Accepted. February 23, 2006. See pdf and html of the draft report at: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2006.html>.

“The GHG Protocol for Project Accounting,” World Resources Institute and the World Business Council for Sustainable Development released this protocol in December 2005. The protocol is a tool for determining the greenhouse gas emission reduction benefits of climate mitigation projects. It aims at developing accounting and reporting standards and/or general guidance for both emission reduction and land use, land-use change and forestry (LULUCF) projects. Download at: <http://www.ghgprotocol.org/plugins/GHGDOC/>

[details.asp?type=DocDet&ObjectId=MTc0MTg](http://www.ghgprotocol.org/templates/GHG5/layout.asp?type=p&MenuId=ODQ5). Also see the Corporate GHG Accounting and Reporting Standard at: <http://www.ghgprotocol.org/templates/GHG5/layout.asp?type=p&MenuId=ODQ5>.

Greenwire, “New Zealand, Sweden, Finland Atop Performance Index,”

The pilot 2006 Environmental Performance Index (EPI) was released January 26, 2006. The EPI is a study developed by Yale University and Columbia University in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission. The study ranks 133 countries on 16 indicators tracked in six established policy categories. Within the Sustainable Energy policy category, annual carbon dioxide emissions, measured as metric tons per \$1 million of gross domestic product, average around 363 tons. North Korea, Turkmenistan, Ukraine, Uzbekistan and Mongolia rank at the bottom of the scale, with North Korea at 4,859 tons. Nations with rapid economic expansion, such as China (731 tons) and India (621 tons), emit more than double the world average. The US ranks at 171 tons: behind other major industrial powers such as France (56 tons), Japan (57 tons), Germany (80 tons), Britain (118 tons); closely matching Canada (168 tons); and ahead of Australia (209 tons) and Russia (914 tons). See the full API study and supporting data and documents at <http://www.yale.edu/epi/>. January 30, 2006, http://www.eenews.net/Greenwire/searcharchive/test_search-display.cgi?q=%22Carbon%22&file=%2FGreenwire%2Fsearcharchive%2FNewsline%2F2006%2FJanuary23%2F01230603.htm.

Legislative Activity

White House Press Release, “State of the Union: The Advanced Energy Initiative,”

In his State of the Union Address, President Bush outlined the Advanced Energy Initiative, which provides for a 22% increase in clean-energy research at the Department of Energy (DOE). The President stated that the best way to break the addiction to foreign oil is through new technologies, including advanced energy technologies. The Initiative will accelerate technology in two vital areas: how the US powers homes and businesses, and how it powers its automobiles. Within the Advanced Energy Initiative is the Coal Research Initiative. As part of the National Energy Policy, the President committed \$2 billion over 10 years to increase the pace of research in the use of clean coal technologies to generate electricity while meeting environmental regulations at low cost. The 2007 Budget includes \$281 million for development of clean coal technologies. Also included in the budget is \$54 Million for the FutureGen Initiative. January 31, 2006, <http://www.whitehouse.gov/news/releases/2006/01/20060131-6.html>.

Department of Energy Press Release, “Department of Energy Requests \$23.6 Billion for FY 2007,”

US Secretary of Energy Samuel Bodman announced the Fiscal Year (FY) 2007 proposed budget for the US Department of Energy, requesting \$23.6 billion, a \$124 million increase over the FY 2006 request. These funds are to directly advance the goals of the Ameri-

can Competitiveness Initiative and the Advanced Energy Initiative. Within the budget, \$648.9 million is requested for the Office of Fossil Energy, a \$192.8 million (23 percent) reduction from FY 2006 appropriation. Within the Office of Fossil Energy budget, \$54 million would support the FutureGen initiative in FY 2007, a \$36.2 million increase from FY 2006 with \$203 million planned for FY 2008; and the Carbon Sequestration initiative is requesting \$73.9 million, a \$7.6 million increase from FY 2006. See detailed budget documents at: <http://www.energy.gov/news/3150.htm>. February 6, 2006, <http://www.energy.gov/news/3150.htm>.

Greenwire, "Domenici, Bingham Pinpoint Obstacles to Global Warming Bill," The Senate Energy and Natural Resources Committee's top Republican Pete Domenici (R-NM), and top Democrat Jeff Bingaman (D-NM) have released a white paper outlining their view on the issues that need to be considered in formulating a greenhouse gas bill for consideration in Congress. The paper "Design Elements of a Mandatory Market-Based Greenhouse Gas Regulatory System" outlines the key questions and design elements of a national greenhouse gas program assuming a "mandatory market-based system." Domenici feels that there will be

a greenhouse gas regime in effect in the US at some time in the future. Bingham's goal is to present a bill by 2007. Public comments are to be received and a conference to be held in March to bring together two dozen experts on the issue. Download the white paper at: <http://www.eenews.net/EEDaily/include/print.php?single=02030601>. February 3, 2006, <http://energy.senate.gov/public/files/ClimateChangeWhitePaper.doc>. (Subscription may be required.)

Greenwire, "California Task Force Unlikely to Recommend Emissions Cap," The Climate Action Team set up by California Governor Arnold Schwarzenegger (R-CA) is unlikely to recommend a strict cap on carbon emissions when it reports to the legislature this month. It is also unlikely to propose a specifically defined market-based cap-and-trade program; rather it is expected to allow the state lawmakers and governor to initiate proposals. Governor Schwarzenegger signed Executive Order # S-3-05 on June 1, 2005, establishing greenhouse gas reduction targets, the first of which is for the state to reduce to 2000 emission levels by 2010. To meet the targets, the Governor directed the state environmental agency to set up the action team to recommend how to implement the policy. The task force is more likely to focus on

intermediate steps in its upcoming report to legislature including proposals which would require legislative action: mandatory emissions reporting got the climate registry, "the foundation for a cap-and-trade program," establishing a "public goods" transportation fee to lower dependence on petroleum, and early-action credits towards a future carbon market. February 2, 2006, http://www.eenews.net/Greenwire/searcharchive/test_search-display.cgi?q=sequestration&file=%2FGreenwire%2Fsearcharchive%2FNewsline%2F2006%2FFebruary%2F02020613.htm. (Subscription may be required.)

Contra Costa Times (CA), "Tackling Utilities' Emissions," California regulators voted on February 16 to cap power plant emissions of carbon dioxide despite objections from utilities. The Public Utilities Commission president Mike Peevey said that the commission acted in order to do their part in meeting the greenhouse gas (GHG) goals articulated last year by California Governor Schwarzenegger. Analysts from the California Air Resources Board recently estimated that the costs to meet the GHG reductions of 1990 levels by 2020 is \$8 billion, but that the costs would be offset by savings resulting from more energy efficient use and economic growth. February 17,

2006, <http://www.contracostatimes.com/mld/cctimes/news/local/states/california/13895486.htm>

Greenwire, "California GHG Plan Won't Harm Economy, Think Tank Says," The Center For Clean Air Policy, an independent think tank, reports in its study released January 19, 2006, that California can reach the governor's greenhouse gas emissions targets with a zero net cost to the consumer. The targets are 2000 levels by 2010 (59 million tons reduction), and 1990 levels by 2020 (145 million tons reduction), with a further reduction to 80% below 1990 levels by 2050. The analysis was funded by private foundations and the California Energy Commission. The cost-effectiveness and reduction potential for greenhouse gas mitigation options were analyzed in the transportation, agriculture, forestry, cement and high tech sectors, thus the inclusion of refining and power generation could potentially lead to more cuts. Read the report entitled "Cost Effective GHG Measures for California" at: <http://www.ccap.org/domestic/Summary%20Report-Final%201-19-06.pdf>. January 19, 2006, <http://www.eenews.net/eenewspm/2006/01/19/archive/4/?terms=GHG>. (Subscription may be required.)

Events

March 7-9, 2006, **Planning for the Future: Climate Change, Greenhouse Gas Inventories & Clean Energy Linkages**, *Sheraton Fisherman's Wharf hotel, San Francisco, CA*. This International Specialty Conference is sponsored by the Air & Waste Management Association. It will examine the convergence of policies and technical issues with regards to mitigation of greenhouse gas emissions and the impact on climate change. To download a preliminary program and further information on the conference see: <http://www.awma.org/events/conf/GLOBAL/default.asp> or contact Amy Klaus at (412) 232-3444, ext. 3119, or: aklaus@awma.org

March 8-9, 2006, **Environmental Credits Generated through Land-Use Changes: Challenges and Approaches**, *Hyatt Regency Hotel, Baltimore, MD*. The workshop will be used to study and discuss the challenges that arise when market-based mechanisms are used to encourage changes in practices on the land in order to achieve environmental goals. The primary focus will be on carbon sequestration and nutrient runoff reductions, though lessons will be applicable to a wide range of environmental issues. Space is limited. For more information, to reserve a spot, or to ensure that you receive updates on the program, contact Richard Woodward at: r-woodward@tamu.edu, 979-845-5864. Additional information is available at: <http://www.envtn.org/LBcreditsworkshop/>

Events (Continued...)

April 4 - 5, 2006, **The Wall Street Green Trading Summit**, *The Bloomberg Headquarters, New York City*. This event is the only global conference that embraces the triple convergence of the capital markets and all environmentally traded markets including greenhouse gases, renewable energy and "negawatts." Session topics include carbon market developments, carbon sequestration and enhanced oil recovery, and new advances in renewable energy trading. Attend in person or via live webcast. For further information, please go to https://www.hedgeconnection.com/atlas/event_viewer.php?eid=2 or call Lisa Vioni at +1-941-240-0153.

April 19-21, 2006, **California Climate Action Registry Annual Conference**, *Laguna Cliffs Marriott Resort, Dana Point, CA*. The Registry's annual conference brings together thought-leaders on climate change to take a hard look at developing climate policies, standards and trends. For full details and agenda visit: <http://www.climateregistry.org/EVENTS/Conference> or contact Rachel Tornek with any questions at rachel@climateregistry.org

May 8-11, 2006, **The Fifth Annual Conference on Carbon Capture & Sequestration "Taking Steps Toward Deployment,"** *Hilton Alexandria Mark Center, Alexandria, VA*. The conference will bring together experts directly involved in developing, demonstrating and deploying carbon capture, separation and sequestration technologies as part of the Administration's Climate Change Technology Program. The Conference is sponsored by EM Publications & Forums, in partnership with the US Department of Energy's National Energy Technology Laboratory and other federal agencies. Full details are available at: <http://www.carbonsq.com/>

May 10-12, 2006, **Third Annual CARBON EXPO**, *Congress Centre East, Cologne, Germany*. CARBON EXPO is the global carbon market event that combines the up-to-date content of a high-level conference with the advantages of a trade fair. For additional information visit: <http://www.carbonexpo.com/>

May 21-26, 2006, **The Clearwater Coal Conference, 31st International Technical Conference on Coal Utilization & Fuel Systems**. *Sheraton Sand Key Hotel, Clearwater, FL*. Sponsored by: US Department of Energy, Coal Technology Association & American Society of Mechanical Engineers - Power Division, in cooperation with National Energy Technology Laboratory, US Department of Energy. The program presents an extensive overview of emerging, evolving, and innovative technologies, fuels and/or equipment in the power generation industry. The presentations topics include: technical solutions to problems; specific strategies; projects; innovations; industry trends; and regulatory compliance. Contact Barbara Sakkestad, Coal Technology Association, Phone: 301/294-6080. E-mail: Barbarasak@aol.com; or the website: <http://www.coaltechnologies.com>.

June 19-22, 2006, **GHGT-8**, *Norwegian University of Science and Technology (NTNU), Trondheim, Norway*. The aim of this conference is to provide a forum for the discussion of the latest advances in the field of greenhouse gas control technologies. Details at: <http://www.ghgt-8.no>

For subscription details, please visit: http://www.netl.doe.gov/publications/carbon_seq/subscribe.html. To learn more about DOE's Carbon Sequestration Program, please contact Sean Plasynski at: sean.plasynski@netl.doe.gov or Dawn Deel at: dawn.deel@netl.doe.gov.